(19) Europäisches Patentamt
European Patent Office
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(11) **EP 1 810 702 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.07.2007 Bulletin 2007/30

(51) Int Cl.:
A61M 1/00 *(2006.01)* ***F04B 43/12*** *(2006.01)*

(21) Application number: **07100305.7**

(22) Date of filing: **09.01.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **24.01.2006 US 338491**

(71) Applicant: **Alcon, Inc.**
6331 Hünenberg (CH)

(72) Inventors:
- **Hopkins, Mark A.**
  Mission Viejo, CA 93691 (US)
- **Salari, Kamran**
  Irvine, CA 92602 (US)
- **Williams, David L.**
  Newport Beach, CA 92633 (US)

(74) Representative: **Hanna, Peter William Derek et al**
Hanna, Moore & Curley
13 Lower Lad Lane
Dublin 2 (IE)

(54) **Improved surgical cassette**

(57) A cassette (18) is provided having an elastomeric sheet (20) that is bonded or mechanically attached to a rigid substrate (22). A flow channel (27) is molded into the rigid substrate that corresponds to a flow channel (26) molded into the elastomeric sheet. The cassette is used in combination with a peristaltic pump (10) having pump head rollers (16) that are mounted radially from the axis of rotation of the pump motor (12) so as to compress the elastomeric flow channels against the rigid substrate during operation. The flow channels (27) molded into the rigid substrate have smooth, fluid lines free from sharp edges and abrupt direction changes and correspond with the fluid channels (26) molded into the elastomeric sheet so as to provide a transition region (34) with a relatively constant cross-section over its entire length that approximates to the cross-sectional area ofthe flow channels (27) molded into the rigid substrate and the fluid channel (26) molded into the elastomeric sheet, so that the entire fluid path is of relatively constant cross-sectional area.

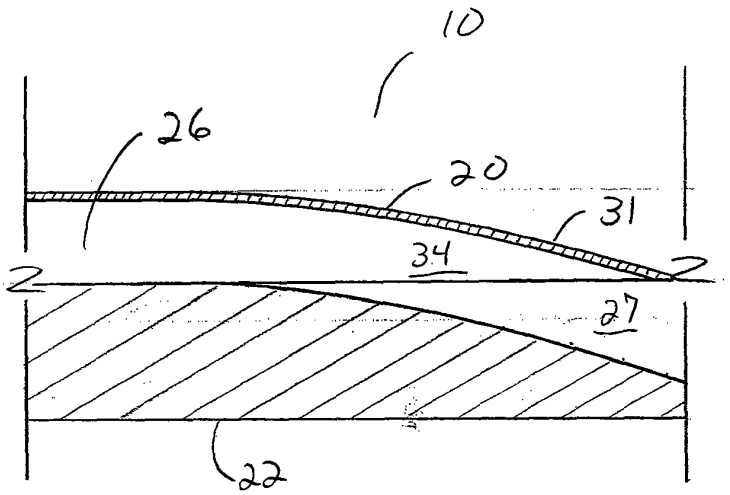

FIG. 5

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Description

Background of the Invention

[0001] The present invention relates generally to peristaltic pumps and more specifically to peristaltic pumps used in ophthalmic surgical equipment.

[0002] Most prior art peristaltic pumps work by compressing or squeezing a length of flexible tubing (sometimes between a fixed race) using a rotating roller head. As the roller head rotates, the rollers pinch off a portion of the tubing and push any fluid trapped in the tubing between the rollers in the direction of rotation. Peristaltic pumps are widely used in medical applications because of their predictable, constant flow properties. These prior art systems, however, typically require manual connection of the pump tube segment around the rotating roller head.

[0003] Prior art peristaltic pumps using rotating roller heads also typically impart unwanted pressure pulsations. Several pulsation damping devices have been developed to address this problem (see e.g., U.S. Patent No.4,921,477 (Davis)).

[0004] Some prior art cassettes have tapered sections of pump tube so that the compression of the tube is more gradual and less abrupt. See for example U.S. Patent No. 6,293,926 B1 (Sorensen, et al.). This tapering of the pump tubing has helped reduce pressure pulsations, but additional reduction is desirable.

[0005] Accordingly, a need continues to exist for a peristaltic pump that reduces pressure pulsations.

Brief Summary of the Invention

[0006] The present invention improves upon prior art peristaltic pump cassettes by providing a cassette having an elastomeric sheet that is bonded or mechanically attached to a rigid substrate. A flow channel is molded into the rigid substrate that corresponds to a flow channel molded into the elastomeric sheet. The cassette is used in combination with a peristaltic pump having pump head rollers that are mounted radially from the axis of rotation of the pump motor so as to compress the elastomeric flow channels against the rigid substrate during operation. The flow channels molded into the rigid substrate have smooth, fluid lines free from sharp edges and abrupt direction changes and correspond with the fluid channels molded into the elastomeric sheet so as to provide a transition region with a relatively constant cross-section over its entire length that approximates the cross-sectional area of the flow channels molded into the rigid substrate and the fluid channel molded into the elastomeric sheet so that the entire fluid path is of relatively constant cross-sectional area.

[0007] One objective of the present invention is to provide a cassette that uses molded elastomeric flow channels.

[0008] Another objective of the present invention is to provide a cassette for a peristaltic pump having radially oriented pump rollers.

[0009] Yet another objective of the present invention is to provide a cassette for a peristaltic pump having pump rollers that compress elastomeric flow channels in the cassette against a rigid substrate.

[0010] Still another objective of the present invention is to provide a cassette having fluid channels molded into a rigid substrate, the flow channels having smooth, fluid lines free from sharp edges and abrupt direction changes.

[0011] Still another objective of the present invention is to provide a cassette having fluid channels molded into a rigid substrate, the flow channels correspond with fluid channels molded into an elastomeric sheet so as to provide a flow channel with a relatively constant cross-section over its entire length.

[0012] Yet another objective of the present invention is to provide a conssette have a fluid pathway that is of relatively constant cross-sectional area.

[0013] These and other advantages and objectives of the present invention will become apparent from the detailed description, drawings and claims that follow.

Brief Description of the Drawings

[0014]

FIG. 1 is a schematic top plan view of the peristaltic pump of the cassette of the present invention, with the motor and roller head removed for clarity.

FIG. 2 is a schematic side elevational view of the peristaltic pump of the cassette of the present invention, with the motor and roller head removed for clarity.

FIG. 3 is a cross-sectional view of the peristaltic pump of the cassette of the present invention taken at line 3-3 in FIG. 1.

FIG. 4 is a partial cross-section view of a prior art cassette fluid channel.

FIG. 5 is a partial cross-sectional view of the cassette fluid channel of the present invention.

Detailed Description of the Invention

[0015] As best seen in FIGS. 1, 2 and 3, pump 10 of the present invention generally includes pump motor 12, roller head 14, containing one or more rollers 16 and cassette 18 having elastomeric sheet 20 applied to the exterior of relatively rigid body or substrate 22. Pump motor 12 preferably is a stepper or D.C. servo motor. Roller head 14 is attached to shaft 24 of motor 12 so that motor 12 rotates roller head 14 in a plane generally normal to axis 25 of shaft 24, and the longitudinal axes of rollers 16 are generally radial to axis 25 of shaft 24.

[0016] Sheet 20 contains molded fluid channel 26 and substrate 22 contains molded fluid charmel 27, that are generally arcuate in shape where fluid channel 26 meets

roller head 14, with fluid channel 26 having a radius approximating that of rollers 16 about shaft 24. Fluid channels 26 and 27 fluidly connect pump inlet and pump outlet ports ports 28 and 30. Sheet 20 may be made of any suitably flexible, easily molded material such as silicone rubber or thermoplastic elastomer. Sheet 20 is attached or bonded to substrate 22 by any suitable technique such as adhesive, heat fusion or mechanical crimping. Substrate 22 preferably is made of a material that is rigid with respect to sheet 20, such as a rigid thermoplastic, and may be made by any suitable method, such as machining or injection molding.

[0017] In use, cassette 18 is held in close proximity to roller head 14 so that rollers 16 compress channel 26 against substrate 22 as roller head 14 rotates. The longitudinal axes of the rollers are arranged so that roller 16 contact with channel 26 is generally parallel with the plane of channel 26. Such an arrangement eliminates the need to loop a length of flexible tubing over the pump roller head and thus simplifies the loading of pump channel 26 against pump roller head 14. Rollers 16 may be tapered along their axial length to accommodate the difference in path length traveled by the inner and outer sections of rollers 16 as roller head 14 rotates.

[0018] As best seen in FIG. 4, prior art peristaltic pumps have an elastomeric sheet 120 adhered to relatively rigid substrate 122, forming fluid channel 126. The fluid pathway into fluid channel 126 includes fluid channel 127 that is molded into substrate 122. Fluid channel 127; however, contains relatively sharp corner 129 and other abrupt obstructions (not shown) and the cross-sectional area of fluid channel 126 varies at ramped or tapered section 131. These features can allow some pump pulsations to enter the fluid being pumped.

[0019] As best seen in FIG 5, substrate 22 of the present invention contains molded fluid channel 27 that provides the fluid input to fluid channel 26. Channels 26 and 27 are smoothly curving and are relatively freed from sharp edges and abrupt obstructions. The shape of channel 27 is such that it corresponds to ramped or tapered section 31 of sheet 20, so as to provide transition fluid channel region 34 between substrate 22 and sheet 20 having a relatively constant cross-sectional area that approximates the cross-sectional area of fluid channels 26 and 27. In other words, channels 26 and 27 and transition fluid channel region 34 form a constant fluid pathway in cassette 18 that is of relatively constant cross-sectional area. Such a relatively constant cross-sectional area helps prevent the introduction of pulsations in fluid channels 26 and 27 when sheet 20 is compressed against substrate 22 by rollers 16.

[0020] This description is given for purposes of illustration and explanation. It will be apparent to those skilled in the relevant art that modifications may be made to the invention as herein described without departing from its scope or spirit.

Claims

1. A surgical cassette (18) having a body (22) defining a rigid substrate for use in combination with a peristaltic pump (10) having pump head rollers (16) adapted to compress an elastomeric flow channel against the rigid substrate during operation, said cassette being **characterized by**
an elastomeric flow channel comprising;

(a) a relatively flexible sheet (20) attached to the exterior of the body (22), the sheet containing at least one channel molded in the sheet, so as to define at least one first fluid channel (26) formed on the exterior of the body and having a tapered section (31); and
(b) at least one second fluid channel (27) molded in the body (22) and located so as to correspond with the tapered section (31) of the at least one first fluid channel (26) to form a transition fluid channel region (34), the transition fluid channel region being of relatively uniform cross-sectional area.

2. The cassette of claim 1, wherein at least one of the first fluid channel (26) and the second fluid channel (27) is/are adapted to be fluidly connected to a pump inlet port (28).

3. The cassette of claim 1, wherein at least one of the first fluid channel (26) and the second fluid channel (27) is/are adapted to be fluidly connected to a pump outlet port (30).

4. The cassette of claim 1, wherein the sheet (20) comprises a flexible, easily molded material.

5. The cassette of claim 4, wherein the sheet (20) comprises silicone rubber or thermoplastic elastomer.

6. The cassette of any of claims 1 to 5, wherein the cross-sectional area of the transition fluid channel region (34) approximates to the cross-sectional area of the at least one first fluid channel (26).

7. The cassette of any of claims 1 to 5, wherein the at least one first fluid channel (26), the at least one second fluid channel (27), and the transition fluid channel region (34) all are of approximately the same uniform cross-sectional area.

8. The cassette of any of claims 1 to 5, wherein the at least one first fluid channel (26), the at least one second fluid channel (27), and the transition fluid channel region (34) comprise a fluid pathway that is of relatively constant cross-sectional area.

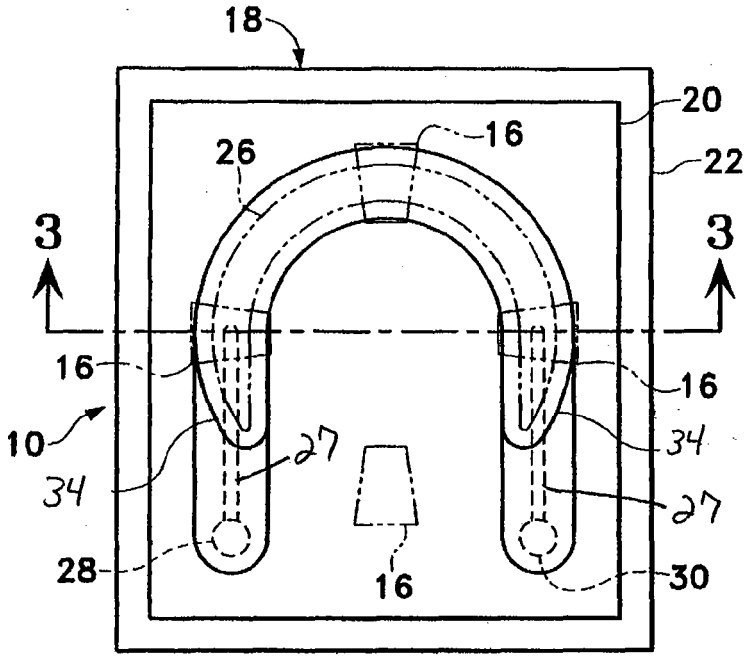

FIG. 1

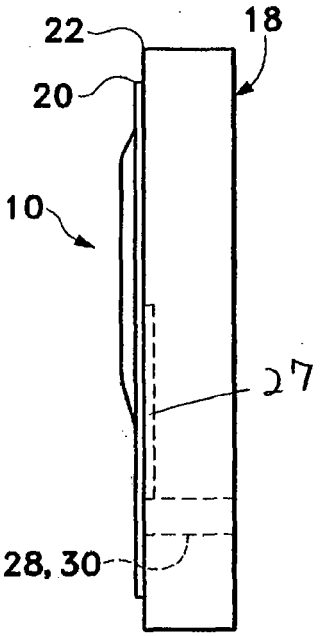

FIG. 2

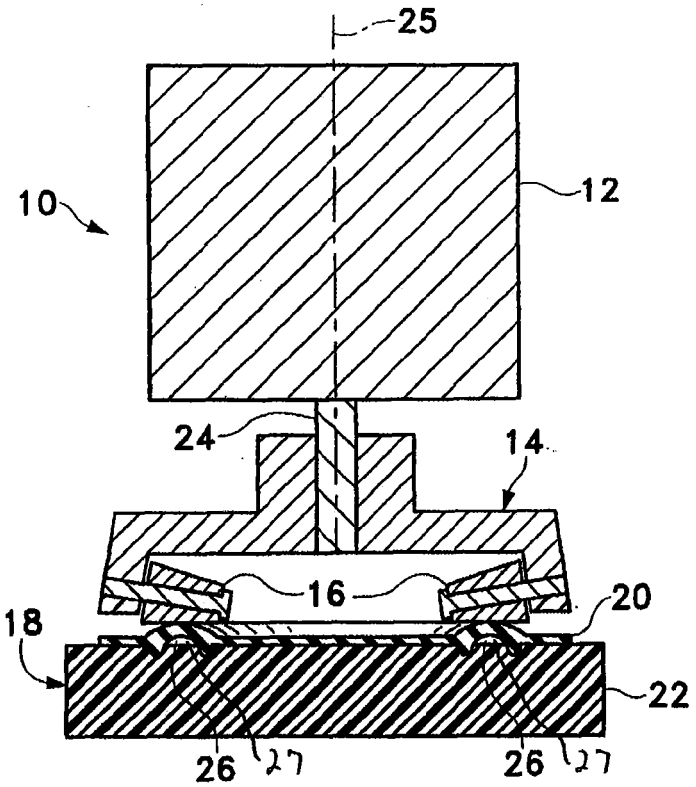

FIG. 3

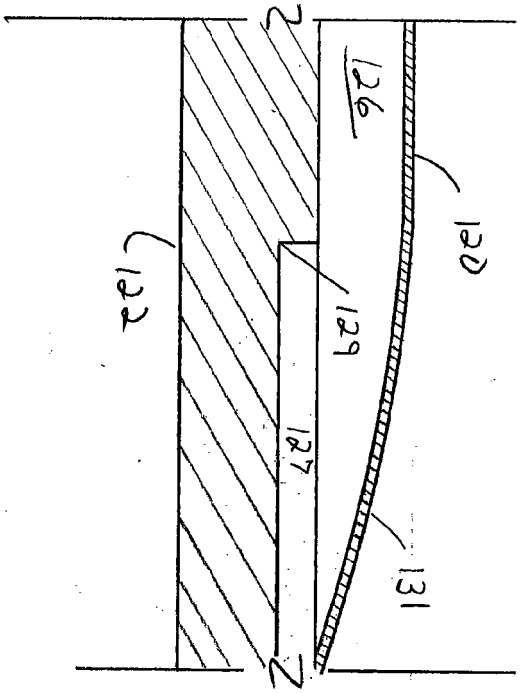

FIG. 4

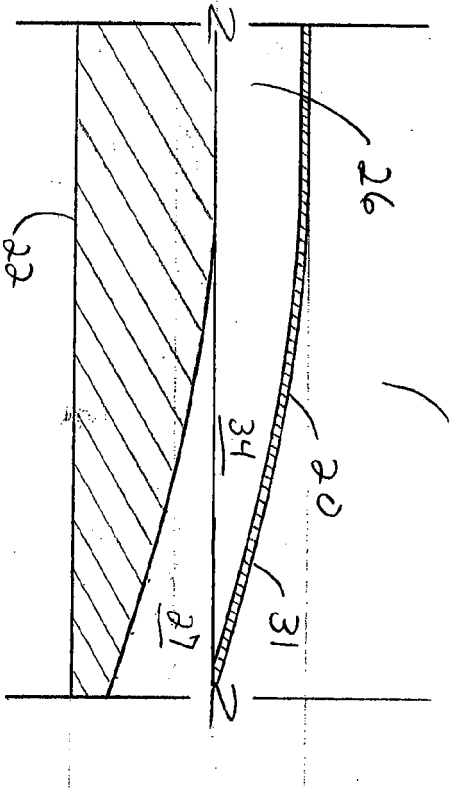

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 07 10 0305

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A	DE 35 42 454 A1 (SWOBODA WALTER) 4 June 1987 (1987-06-04) * figures 1,2 * * column 4, line 61 - column 5, line 19 * * column 5, line 65 - column 6, line 3 *	1-3	
A	US 4 494 285 A (O'BOYLE MATTHEW [US]) 22 January 1985 (1985-01-22) * figures 1-3,11 * * column 3, line 64 - column 4, line 16 * * column 5, lines 9-20 * * column 5, lines 51-56 * * column 6, lines 28-41 *	1-3	TECHNICAL FIELDS SEARCHED (IPC) A61M F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 May 2007	Hochrein, Marion

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 10 0305

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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